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EXAMINER	
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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 14

Application Number: 08/809,463
Filing Date: 7/18/97
Appellant(s): Nakamura et al.

Michael R. Hull
For Appellant

EXAMINER'S ANSWER

This is in response to appellant's brief on appeal filed 8/24/99.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The brief states that there are no related appeals or interferences.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant states that Appellant argues for the patentability of the dependent claims 5, 6, 8, 15, 16 and 18 separate and apart from the independent claims from which they depend.

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

The following is a listing of the prior art of record relied upon in the rejection of claims under appeal.

U.S. 5,098,859	Jackson et al.	24 Mar. 1992
DE 41 29 647 A1	Nirschl et al.	02 Apr. 1992
JP 59-66166 (A)	Ishihara	14 Apr. 1984

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. Claims 1-4, 7, 9-14, 17 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jackson et al. (U.S. # 5,098,859, "Jackson") in view of Nirschl et al. (DE 41 29 647 A1; "Nirschl").

Jackson discloses a device including a GaAs substrate, a non-single crystal semiconductor layer (see, for example, "EXAMPLE 3" as well as col. 5, line 56), and an uppermost conductive film. With respect to claims 9 and 19, note figure 2. Jackson fails to teach the claimed details of the uppermost conductive film (Jackson's "metal 1"). Nirschl teaches a metal film structure for making contact with III-V semiconductor regions. Nirschl's structure includes a first metal layer (2), a nitride layer (5), an adhesion layer (6) and a second metal layer (4). Nirschl teaches that such a contact structure allows for reliable operation at

high temperatures because of the forming of the diffusion barrier TiWN. Accordingly, from the suggestion of Jackson that "the metal is not critical and any metal will make a good contact" (column 6, lines 7-10) and from the teaching of Nirschl above, it would have been obvious to one skilled in the art at the time the invention was made to form the device as disclosed by Jackson with a conductive film structure as taught by Nirschl because Nirschl teaches that such a contact structure can be used to contact III-V material and allows for reliable high temperature operation. With respect to claims 7 and 17, While Nirschl uses a metal and nitride other than those claimed by Appellant, the claimed metals and nitrides are well known in the art and their use in Nirschl's structure would have been obvious to a skilled artisan at the time of invention as a result of routine engineering design, optimization, and implementation considerations.

2. Claims 5, 6, 8, 15, 16, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jackson and Nirschl and further in view of Ishihara (Kokai 59-66166).

Jackson and Nirschl teach a device as claimed, but fail to specify that the adhesion layer is formed of a refractory metal (or, for that matter, what refractory metal). Ishihara teaches a related prior art structure which uses titanium as an adhesive layer (the Examiner notes the while the English abstract refers to the adhesive force of the uppermost layer, one skilled in the art would readily understand that the adhesive force is a result of layer 7). It would have been obvious to one skilled in the art at the time the invention was made to form the device collectively taught by Jackson and Nirschl with a refractory metal layer as Nirschl's

adhesive layer due to Ishihara's successful use of such a material for such a layer in a related prior art device. With respect to claims 8 and 18, Ishihara discloses the use of a titanium refractory metal other than the use of refractory metals of W, Ta, and Mo as claimed. However, because W, Ta, Mo and Ti are well known refractory metals and commonly used in the art for the well known purpose of reducing the contact resistances, it would have been obvious to select W, Ta, or Mo for Ishihara's Ti because of their equivalence for their use in the semiconductor art as conductive materials and the selection of any of these known equivalents to be used as a low resistivity conductive material would be within the level of skill in the art.

(11) Response to Argument

A) With respect to the obviousness rejection based on the combination of Jackson and Nirschl, Appellant argues on pages 8-9 of brief (issue 1) that there is no motivation to combine them because Jackson does not teach the forming of the metal nitride layer and because Nirschl teaches the metal contact in a higher band gap compound semiconductor material, but does not teach the metal contact in devices that incorporate a lower band gap semiconductor material (i.e. InSb or InAs) between the metal and the higher band gap compound semiconductor as claimed.

The Examiner has recognized these shortcomings and what Appellant argues is not shown by one reference is clearly taught by the other. Thus, these arguments are arguments

against the references individually but, clearly, these are not proper arguments where references are applied in combination. *In re Keller*, 642 F. 2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). The Examiner relies on the combined teachings at Jackson and Nirschl. Nirschl is not relied on for teaching the metal contact in devices that incorporate a lower band gap semiconductor material between the metal and the higher band gap compound semiconductor. Jackson discloses the metal contact in devices that incorporate a lower band gap semiconductor material InAs between the metal and the higher band gap compound semiconductor GaAs (see "EXAMPLE 3"). Nirschl is relied on for showing that it was known to form a diffusion barrier of metal nitride on a III-V compound semiconductor material.

The Examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, Appellant's claim 1, for example requires three elements: (1) a III-V compound semiconductor body, (2) a non-single crystal semiconductor layer comprising In, and (3) a film including at least a metal nitride film. Turning to the cited prior art, Jackson discloses an improved contact to a III-V compound semiconductor body (GaAs). This improvement includes a non-single crystal semiconductor layer comprising In formed atop the

III-V compound semiconductor body. Jackson completes this structure by forming a layer of metal atop the non-single crustal semiconductor layer comprising In. With respect to the metal layer, Jackson observes that "the metal is not critical and any metal will make a good contact" (Column 6, lines 7-10). Thus, Jackson's structure differs with respect to claim 1 only with respect to the upper metal layer, which Jackson teaches may be any metal at all. Moving on to the secondary reference, Nirschl teaches an improvement to a metal contact to a III-V semiconductor layer. This improvement includes a first metal layer (2) formed atop a III-V body, followed by a metal nitride layer (5) followed by an adhesion promoting layer (6) followed by a final metal layer (4). Accordingly, from the suggestion of Jackson that "the metal is not critical and any metal will make a good contact" (column 6, lines 7-10) and from the teaching of Nirschl of forming a metal nitride on a III-V compound semiconductor material for preventing the diffusion (see Nirschl's abstract), one skilled in the art when taking these two teachings collectively would have been motivated to form Jackson's upper metal layer in the manner taught by Nirschl because Nirschl's upper metal layer is disclosed as an improved metal contact to a III-V compound semiconductor material, the very function of Jackson's upper metal layer.

With respect to the obviousness rejection based on the combination of Jackson, Nirschl and Ishihara, Appellant also argues on pages 8-9 of brief that there is no motivation to combine Ishihara with the other applied references because Ishihara teaches the use of an

adhesive refractory metal film, but not teach the forming of a non-single crystal layer comprising In in a multi-layered structure .

Again, this argument has no immediate apparent relevance to the issues presented by the rejection since Appellant cannot show nonobviousness by attacking references individually where the rejection is based upon a combination of references. *In re Young*, 403 F. 2d 754, 757, 159 USPQ 725, 728 (CCPA 1968). The Examiner relies on the combined teachings of Jackson, Nirschl and Ishihara. Jackson discloses the forming of a non-single crystal layer comprising In in a multi-layered structure. Ishihara is relied on only for teaching the use of Ti as an adhesion layer in a multi-layer contact structure. The Examiner maintains that Nirschl's description of a layer solely in terms of its adhesive property together with Ishihara's successful use of titanium as an adhesive layer in a multi-layer structure provides sufficient motivation to one skilled in the art to use titanium and the adhesive layer in the collectively taught structure.

B) With respect to dependent claims 5, 6, 8, 15, 16, and 18, Appellant argues on pages 11-12 (issue 3) and page 10, first paragraph of brief that it would no be obvious to combine Ishihara with the other applied references because Ishihara fails to teach the refractory metal film as claimed.

These arguments are also not persuasive because of the reasons as set forth above which are incorporated herein by reference. Specifically, with respect to claims 5, 6, 15, and 16, Ishihara teaches a related prior art structure which uses titanium as an adhesive layer.

Therefore, it would have been obvious to one skilled in the art at the time the invention was made to form the device collectively taught by Jackson and Nirschl with a refractory metal layer as Nirschl's adhesive layer due to Ishihara's successful use of such a material for such a layer in a related prior art device. With respect to claims 8 and 18, the Examiner agrees that Ishihara discloses the use of a refractory metal film of titanium other than the use of a refractory metal film of W, Ta or Mo as claimed. However, because W, Ta, Mo and Ti are well known refractory metals and commonly used in the art for the well known purpose of reducing the contact resistances, it would have been obvious to select W, Ta, or Mo for Ishihara's Ti because of their equivalence for their use in the semiconductor art as conductive materials and the selection of any of these known equivalents to be used as a low resistivity conductive material would be within the level of skill in the art.

C) Appellant argues on pages 10-11 of brief (issue 2) that neither Jackson nor Nirschl suggest the claimed invention because Jackson teaches the forming of a multi-layered structure having an InAs crystal formed on a GaAs body, but does not teach the forming of a metal nitride film on this multi-layered structure for the purpose of preventing the diffusion of the underlaying layer to the electrode surface during annealing, and because Nirschl teaches the forming of a multi-layered structure having a metal nitride film formed on a III-V compound body, but does not teach the forming of an InAs crystal on a III-V compound body for the purpose of providing a reliable ohmic electrode exhibiting thermal stability and low contact resistance.

Once again, as already discussed in detail above, the Examiner has recognized these shortcomings and what Appellant argues is not shown by one reference is clearly taught by the other. Thus, these arguments are arguments against the references individually but, clearly, these are not proper arguments where references are applied in combination. *In re Keller*, 642 F. 2d 413, 425, 208 USPQ, 871, 881 (CCPA 1981). The Examiner relies on the combined teachings at Jackson and Nirschl. Nirschl is not relied on for teaching the forming of an InAs crystal on a III-V compound body. Jackson discloses the forming of an InAs crystal on a III-V compound body. Nirschl is relied on for teaching the forming of a metal nitride film on a III-V compound body.

Appellant is noted that the reason or motivation to modify the reference may often suggest what the inventor has done, but for a different purpose or to solve a different problem. It is not necessary that the prior art suggest the combination to achieve the same advantage or result discovered by Appellant. *In re Linter*, 458 F. 2d 1013, 173 USPQ 560 (CCPA 1972). In the other words, there is no requirement that the prior art must provide the same reason as the claimed invention. However, Jackson clearly teaches the forming of the multi-layered structure containing an InAs crystal formed on a III-V compound body (GaAs) and a metal formed on the InAs crystal for the same purpose of providing reliable ohmic electrode exhibiting thermal stability and low contact resistance as claimed. And Nirschl clearly teaches the forming of a multi-layered structure including a metal nitride film (TiWN) formed on a III-V compound body for the same purpose of preventing the diffusion of the underlying layer to

the electrode surface during annealing as claimed (see abstract). Accordingly, because Jackson suggests that the forming of "the metal is not critical and any metal will make a good contact" (column 6, lines 7-10) and because Nirschl suggests the forming of a metal nitride film (TiWN) on a III-V compound body for preventing the diffusion of the underlying layers to the electrode surface, it would have been obvious to one skilled in the art at the time the invention was made to form the device as disclosed by Jackson with a conductive film structure as taught by Nirschl because Nirschl teaches that such a contact structure can be used to contact III-V material and allows for reliable high temperature operation by forming a diffusion barrier mtal nitride film. Therefore, Appellant's arguments are not persuasive because the combination of Jackson and Nirschl do suggest the claimed invention as required by indepenedent claims 1, 9, 10 and 19. And in contradictory to Appellant's opinions, the Exmainer has established a *prima facie* case of obviousness. Similarly, with respect to dependent claims 5, 6, 8, 15, 16, and 18, the Exmainer also has established a *prima facie* case of obviousness over the combination of Jackson and Nirschl and further in view of ishihara because Ishihara teaches a well known feature of using titanium as an adhesion layer in a multi-layer contact structure.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

PHAT X - CAO
PC
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